SCIENCE

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THE NICARAGUA CANAL ROUTE.

THE attention which the problem of connecting the Atlantic and Pacific Oceans by means of a ship canal is now attracting lends an interest to any information concerning the Isthmian region and affords an excuse for the publication in SCIENCE of matter more fully published in other less widely circulated media.*

Exact information concerning the Nicaragua Canal Route is derived chiefly from four surveys of the region, made with a view to determining the best route for a ship canal. The first was made by Colonel Childs, in the interest of the Vanderbilt Transit Company, which held a concession from the Nicaraguan government for constructing a canal. The second was made by Commander Lull, under instructions from the Secretary of the Navy. These two surveys amounted to a good reconnaissance and served to show that no insurmountable obstacles were to be met with. The third survey was that made by the Maritime Canal Company, under the direction of Chief Engineer A. G. Menocal. This extended over several years, and was much more comprehensive than either of the

* Physiography and Geology of region adjacent to the Nicaragua Canal Route. *Bul. Geol. Soc. Am.*, vol. 10, pp. 285-348. 1899.

Physiography of the Nicaragua Canal Route. *Nat. Geog. Mag.*, July, 1899.

Appendix 2, report of the Nicaragua Canal Commission, 1897-99. Govt. Print. In press.

others. It resulted in the location of a route and the formation of final plans, on which construction was begun. Financial difficulties brought the work to a stop, and a proposition to transfer the concession and property of the Company to the United States brought the matter before Congress. In order to obtain information on which to base its action, Congress provided for the appointment of a commission to determine the feasibility and cost of the undertaking. This commission, of which Colonel Ludlow was president, made no actual surveys, but examined the route selected by the Canal Company, and its surveys, plans and estimates. As a result of this examination the commission doubled the estimates of cost made by the Company, and suggested material modifications in the plans adopted. It recommended that further investigation of the route be made before final action was taken by Congress. In accordance with this recommendation a new commission was authorized and appointed in 1897. This commission, of which Rear Admiral Walker was president, employed a large corps of engineers and carried on active field operations throughout the greater part of 1898. The work was conducted under the immediate supervision of Chief Engineer E. S. Wheeler, to whom the excellence of the results obtained is largely due.

This fourth survey of the canal region has been made on a somewhat more comprehensive plan than any of the others, and, while former work has been utilized, every important point has been carefully verified. Special attention has been paid to two subjects, hydrography and geology, concerning which, as pointed out by the Ludlow commission, the available information was extremely meager. Mr. A. P. Davis and the writer were detailed from the Geological Survey to conduct the investigations on these subjects.

Mr. Davis established a large number of stations, at which the streams were gauged and the rainfall and evaporation measured. The importance of his observations and deductions is shown by the material modifications they have necessitated in the Canal Company's plans.

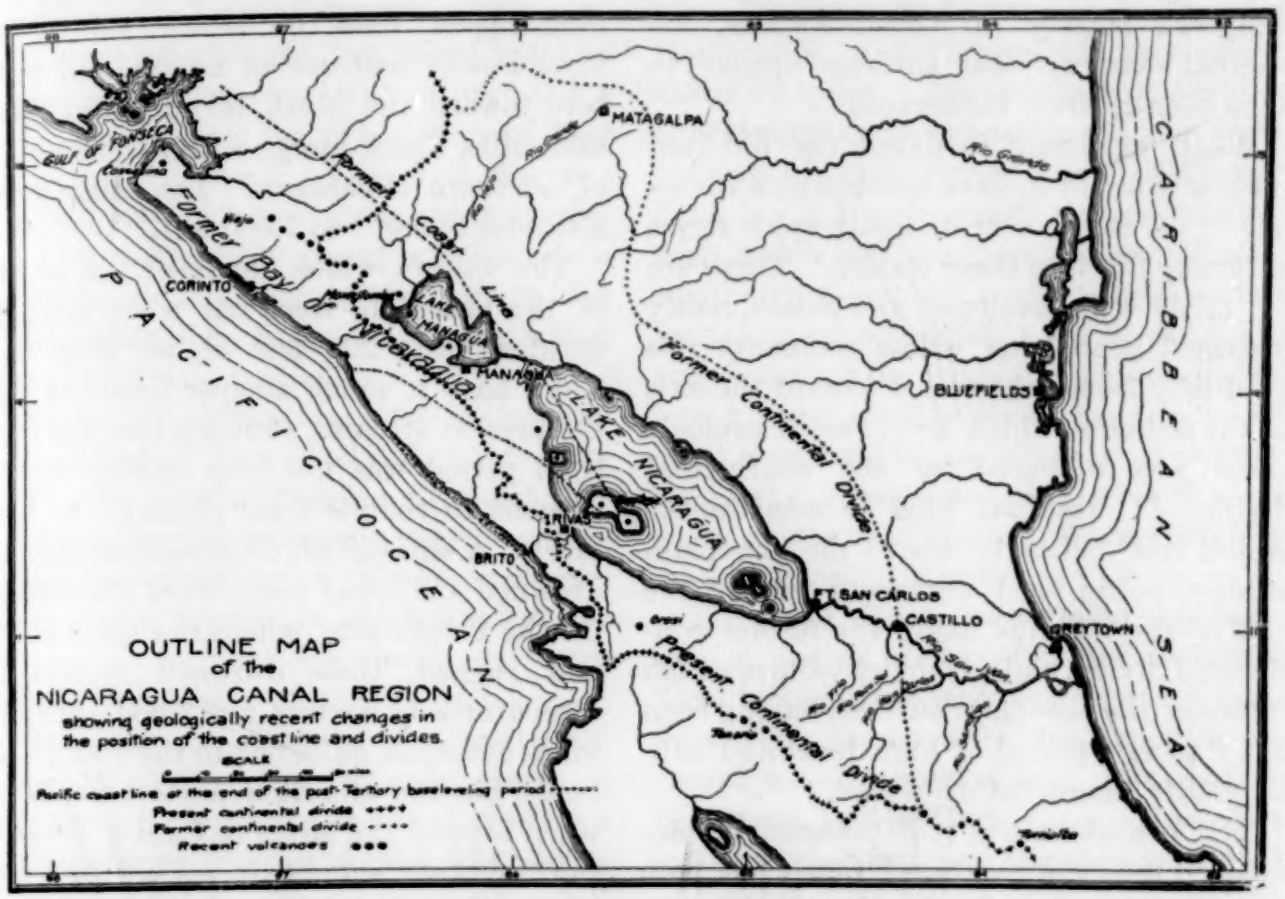
The geologic work consisted in a systematic examination of the region adjacent to the canal route and in an examination of sub-surface conditions by means of the drill. Ample facilities were afforded for the latter, and a mass of exact information was obtained as a basis for estimates by the engineers. Owing to the great depth of rock decay in this region and the extensive accumulations of alluvium, estimates both for foundations and for excavations made without the data furnished by the drill are open to serious question.

Until the investigations of the Walker commission the information obtained by the various surveys was such as comes strictly within the purview of the engineer, and many facts having the most direct bearing upon the canal problem were entirely overlooked or ignored.

Notwithstanding the large amount of work done by eminent engineers in this portion of Central America, its physiographic features have never been adequately described. As late as the report of the Ludlow commission the conventional Humboldtian view of the topography prevails. According to this view, which should be definitely discarded at the outset, a continuous mountain chain connects the Cordilleran system of western North America with the Andean system of western South America. Hill has fully demonstrated the falsity of this old view and shown the complete independence of the orographic systems of the three Americas.

The most striking physiographic feature in this portion of Central America, and the one which has the most direct practical

bearing on the location of a canal route, is the great depression which extends diagonally across the isthmus, holding the Lakes Managua and Nicaragua and their outlet the San Juan River. Its southwestern margin is formed by the lofty volcanic range of northern Costa Rica, while it is less definitely limited on the northeast by the Chontales hills, which extend from the Caribbean coast westward to the lakes. The *Nicaraguan Depression*, as above outlined, is not a simple river valley, although it is now occupied by a single trunk stream and its tributaries. Except for the constructional volcanic slopes at its southern margin, the depression is due entirely to ordinary stream erosion. During its formation, however, the continental divide occupied a position near the axis of the isthmus, while the western coast was indented by a deep bay reaching to the center of the present basin of Lake Nicaragua. The relations of present to former divides and coast lines are shown on the accompanying map.



Considering a broad belt extending across the isthmus and embracing the Nicaraguan depression, three distinct types of topography are encountered, viz. :

Old-land areas with maturely developed degradational surfaces.

Recent flood-plains and deltas with still-forming aggradational surfaces.

Recent volcanic cones and plateaus with slightly modified constructional surfaces.

The old-land occupies much the larger portion of the region represented on the accompanying map. It forms the greater part of the Nicaraguan depression and expands northward between the divergent lines of the Caribbean coast and the Nicaragua-Managua lake basins. It also forms the narrower part of the land strip between lake Nicaragua and the Pacific. This old-land surface appears to have been above

sea level since the middle of the Tertiary, and its form is due entirely to the action of subaerial gradational forces. Although composed largely of volcanic rocks, the original constructional surfaces appear to have been entirely obliterated.

When examined in detail the old-land surface is found to have considerable diversity in its relief, and its topographic forms naturally fall into three classes. These are (1) fairly well developed and subsequently dissected peneplains whose remnants rise gradually from either coast toward the axis of the isthmus, which until recent geologic times was occupied by the continental divide; (2) residual hills or monadnocks which rise distinctly above the peneplain surface, being most numerous toward the axis of the isthmus along the former continental divide, and (3) many valleys which intersect the peneplain surface, having been cut during a period of high level and subsequently somewhat depressed.

The peneplain was most extensively developed near the east coast, but it has here suffered most from subsequent erosion, and only a few remnants occur along the lower portion of the San Juan Valley. Higher up the valley, at a distance of 40 or 50 miles from the Caribbean coast, the peneplain was well developed, and, although deeply dissected, the even summits of the hills, about 150 feet above sea level, and considerable areas of level country back from the river, give evidence of its former extent. To the west of the former divide a corresponding peneplain is found sloping gently westward. It forms a plain of variable width about the lower portion of Lake Nicaragua and doubtless extends beneath the waters of the lake.

As indicated above, the residual hills are most numerous near the position formerly occupied by the continental divide, being separated by low colls, in which opposing streams headed, slightly above the level of the peneplain. The San Juan Valley, where it crosses this monadnock belt, is very narrow and bordered by high hills with serrate outlines totally unlike the low even-topped hills on either side. The monadnocks increase in height and numbers toward the north, forming the Chontales hills, which merge with the mountains of northern Nicaragua. The latter reach altitudes of 5,000 to 7,000 feet.

The valleys which intersect the surface of the peneplain were cut when the land stood at least 200 feet higher than now. They have a much steeper gradient than the present streams, showing that the high-level period was not long enough for the streams to reduce their channels to base-level. A subsequent depression of the land drowned the lower portions of the valleys. On the Pacific side, where the coast is bold and rugged, these drowned valleys are comparatively narrow and filled with alluvium nearly or quite out to the rocky headlands, but the alluvium never extends seaward beyond the latter to form a delta. On the Caribbean side the rivers are longer and deliver more sediment than the waves and littoral currents can dispose of, and hence have not only filled the estuaries formed in the drowned valleys, but have built out a series of deltas which coalesce and form a coastal plain. The sediment brought down to the sea by streams north of the San Juan is small compared with that brought down by those to the south. The more rapidly growing southern deltas would, therefore, be extended seaward except for a strong northward sand current set up by the oblique direction at which the waves strike the shore. This sand current tends to distribute the sediment evenly along the coast and preserve gently curving coast lines. Sediment, however, is delivered by the San Juan slightly faster than it can be distributed. Hence it tends to build out a delta, but this is deflected to the northward and forms a curved sandspit which for a

time makes a sheltered harbor. As the sandspit continues to grow, its point eventually joins the mainland, and the harbor is converted into a closed lagoon. This complete cycle of changes has taken place at Greytown during the last century and a half, as shown by the early maps of that portion of the coast. The cycle has also been repeated at the same point several times previous to the one of which there is documentary evidence, giving rise to the several distinct lagoons which occur inland from the one last formed.

The surface of the San Juan delta-plain is diversified by occasional hills which were at one time islands fringing the coast, and also by numerous lakes and lagoons due to the uneven distribution of the sediment. At its inner margin it abuts against the foothills or merges with the broad flood-plain of the river.

The San Juan leaves the lake practically clear, and most of the sediment which it delivers at its mouth is received from two large southern tributaries, the San Carlos and the Sarapiqui. These have their source upon the slopes of the Costa Rican volcanoes, and bring down vast quantities of black volcanic sand. Below the mouth of the San Carlos the trunk stream carries more and coarser sediment than any of the smaller tributaries. It has, therefore, built up its flood-plain more rapidly than the tributaries, and the latter are dammed, forming extensive lagoons in the side valleys.

The recent volcanic activity in this region has given rise to two series of vents, having a very striking linear arrangement. The southern series extends diagonally across the isthmus, in northern Costa Rica, terminating near the Pacific in the extinct volcano Orosi. The materials extruded from these vents have built up the massive mountain range which forms the southern border of the Nicaraguan depression. The second series of vents extends northwestward from Madera, on an island in Lake Nicaragua, to Coseguina, on the Gulf of Fonseca. Between Madera and Orosi, the proximate ends of the two lines, is a gap of about 30 miles. The northern vents were at first submarine, extending in a line nearly parallel with the former coast. They have built up a broad, gently-sloping plateau, from which rise, singly and in groups, many symmetrical volcanic cones. Most of these vents are extinct, while a few have been in eruption since the Spanish conquest, but are now quiescent. The older cones have suffered considerable modification by erosion, while the newer ones, and also the plateaus, retain, in a large measure, their original constructional forms.

The rocks of the Nicaraguan depression are, so far as known, Tertiary and later. They include both sedimentary and igneous formations, though the latter greatly predominate. The strip of land between Lake Nicaragua and the Pacific, southward from a point opposite the Island Zapetero, is composed chiefly of sandstone and shales, with some beds of limestone, which Dr. Dall pronounces to be of Tertiary (Oligocene) age. The sandstones contain a large proportion of volcanic matter and might almost be classed as andesitic tuffs. Another area of similar rocks crosses the San Juan Valley between Castillo and the Boca San Carlos, and may originally have been continuous with the area west of the lake. With the exception of this small area of sandstone, the entire San Juan Valley is composed of igneous rocks, including lavas, tuffs, breccias and conglomerates. These are all, so far as known, of Tertiary age. The lavas are chiefly basalts, andesites and dacite. The recent volcanic rocks are chiefly andesites, with a few lava flows of basalt.

The climatic conditions prevailing in this region have a very direct connection with its physiography and form one of the most

important factors in the canal problem. Through the greater part of the year the trade winds prevail with fairly constant direction and force. They are deflected slightly to the north by the high volcanic range of Costa Rica and to the south by the mountains of northern Nicaragua. The low gap across the isthmus constituting the Nicaraguan depression thus receives more wind than would be due to the normal trades, and it is probably this congestion of the air currents that causes the exceptional precipitation of this region. Within the zone of maximum precipitation which embraces the coastal plain and adjacent hills, forming a belt from 50 to 75 miles broad, the annual rainfall reaches nearly 300 inches. Beyond this belt, with increasing distance from the Caribbean coast, it decreases very rapidly, and in the western portion of the region the average annual rainfall is less than a third and in some seasons less than a tenth of that on the eastern coast. More important, however, than the absolute amount of rain is its distribution throughout the year. In the eastern division the rain is distributed with tolerable uniformity through the year. In the western division, on the other hand, there is a distinct dry season of five or six months. These climatic differences give rise directly to very striking differences in vegetation and, either directly or indirectly, to differences in the appearance and structure of the soils, in the topographic forms of the land surface and in the effectiveness of various physiographic processes.

The eastern division is covered by a dense tropical forest wherever the land is sufficiently firm to support large trees. The falling rain is intercepted by the canopy of foliage and filters gradually down to the surface, where the smaller vegetation affords a further protection, so that the soil never receives the direct impact of the rain drops. The abundant forest litter decays rapidly, furnishing a constant supply of the complex organic acids which are chiefly instrumental in promoting rock decay, and the latter process is extremely active. Solid rock is rarely found, except in residual bowlders, at depths less than 40 to 100 feet from the surface. The prevailing soil is a very tenacious, residual, red clay which never becomes dry enough to be intersected by shrinkage cracks and which, although to some extent loosened by roots and insects, resists erosion to a remarkable degree. After a careful study of the region it was concluded that the absence of frost and the presence of the tropical forest more than counterbalance the enormous rainfall and that surface degradation is, on the whole, slower than in most temperate regions.

The western division, particularly that portion lying between the lakes and the Pacific, is characterized by open savannahs and the thin foliaged, thorny forests of a semi-arid region. The forest litter is mostly destroyed by fires during the dry season, so that rock decay is hindered and the soil is wholly unprotected from the torrential rainfall which inaugurates the wet season. The soil, which is never red, but generally dark blue, is alternately intersected by shrinkage cracks and saturated with water, a process which serves to loosen it almost as effectually as frost. It results that the streams, which are alternately rivulets and torrents, bear great quantities of detritus, and the surface degradation is comparatively rapid.

No sedimentary or other records have been found in this portion of Central America which carry its history back to an earlier period than the Tertiary. During the Oligocene there was probably free communication between the waters of the Atlantic and Pacific, the region of the Nicaraguan depression being occupied by a shallow sea in the vicinity of which were many active volcanoes. The extrusion of volcanic materials and the deposition of sediments

continued until late Tertiary time, when the region was elevated, a land barrier cutting off connection between the two oceans, which has never been restored. After a long period of quiesence, during which extensive peneplains were developed on both sides of the continental divide then occupying the axis of the isthmus, the region suffered another elevation and the peneplains were deeply trenched by river valleys. This period of gorge cutting was followed by a subsidence equal to about half the previous uplift. The river valleys were drowned, and the estuaries thus formed have since been in part or entirely silted up.

The renewal of volcanic activity in late Tertiary or post-Tertiary time gave rise to the two mountain ranges above described. The position of the northern series of vents with reference to the coast line was such that when their ejected material had reached the surface of the sea it formed a barrier across the bay which then indented the Pacific coast. This barrier was built gradually higher by successive eruptions, and since in the area behind it precipitation was greater than evaporation the waters rose above sea level and doubtless escaped westward over the barrier during periods of quiesence in the volcanic activity. As the surface of the barrier was raised by the addition of volcanic ejecta, the surface of the impounded waters was raised to a height probably somewhat above the present elevation of Lake Nicaragua. The lake thus formed occupied not only the position of the former bay, but flooded the basins of the tributary streams and was considerably larger than the present Lakes Managua and Nicaragua combined. Its surface finally reached a low point in the continental divide where a west-flowing stream headed against one which occupied the present position of the San Juan. When this point was reached the intermittent escape of the impounded waters across the volcanic dam to the westward was changed for a permanent outlet to the eastward.

The gap when first discovered and overtopped by the rising waters was doubtless in deeply weathered rock and residual clay. It must, therefore, have been cut down very rapidly until the underlying hard rock was reached, when the permanent level of the lake was established which it has retained practically unchanged to the present time. It is quite possible that the gaps through the continental divide to the east and through the divide between the lake and ocean to the west were so near the same level that the impounded waters had for a short time an outlet both to the Atlantic and to the Pacific. The upper Rio Grande is flowing in a partly silted-up rock gorge much too large for the present stream, and it appears probable that this gorge was cut by the outflow from the lake before it was entirely and permanently diverted to the eastward outlet.

Certain features which have a specially direct bearing upon the canal problem should receive a further word of description. One of these is the gap followed by the canal route between the lake and the Pacific, the lowest gap in the continental divide between the Arctic Ocean and the Straits of Magellan.

The lower portion of the lake is bordered by the peneplain above described which, in the vicinity of Rivas, is very perfectly base-leveled. The plain rises gradually westward from the lake shore to the range of hills which forms the divide. These hills are from 500 to 1,200 feet high and extend northward to a point opposite the Island Zapetero where they meet the Jinotepe plateau and their residual old-land forms give place to the even constructional slopes of the latter. A single break occurs in this continuous line of hills, forming the gap between the waters of the Rio Lajas and the Rio

Grande, and whose summit is only 50 feet above the lake and 154 feet above sea level. This gap, which occupies so important a relation to the proposed canal, is the product of the familiar process of stream capture. Owing to the decided advantages possessed by the streams flowing directly to the Pacific over those flowing eastward, at first to the bay indenting the Pacific coast and afterwards to the lake, the former were able to cut backward through the divide into the drainage area of the latter and to divert their headwaters. In this way an eastward-flowing stream originally occupying the position of the Tola, the upper Rio Grande, the Guiscoyol and the Lajas was beheaded and the drainage of a large part of its basin was diverted to the Pacific. The deserted valley of this stream forms the low gap through which the canal route is located. It is so broad and level that accurate instrumental work is required to determine the actual summit of the continental divide.

Considering the origin of Lake Nicaragua, it is manifest that it must originally have extended entirely down to the point where its waters escaped through the gap in the continental divide—that is, to the present Castillo Rapids. This point, however, is now more than 30 miles down the San Juan River from the lake. The upper portion of that river meanders through an alluvial plain which becomes narrower down streams and has evidently been reclaimed from the waters of the lake by sedimentation. It is well recognized that lakes are ephemeral features, and the commonest way in which they are obliterated is by the filling at their upper ends with sediment deposited at the mouths of tributaries. In this case, however, the process is reversed. The area of the lake is being contracted chiefly by filling at its lower end. The filling is being accomplished by the tributaries entering this lower portion of the lake, many of which have been converted into tributaries of the San Juan. The present river channel does not coincide with the position of the river which formerly occupied this basin before it was drowned by the waters of the lake. Its position is dependent on the relative amounts of sediment delivered by the tributaries on either side, and it has been pushed toward the northern side of the old basin by the larger tributaries from the south, the Frio and Poco Sol. This portion of the San Juan may best be described as a *residual river channel*—that is, a broad arm of the lake has been gradually constricted by the deposition of sediment on its margin, and all that remains is the narrow river channel kept open by the current of water flowing from the lake. This hypothesis, verified by borings made in the river channel, has been of material service in so locating the canal line that all rock excavation in this portion between the lake and the Castillo Rapids should be avoided.

While the writer has no intention of touching upon the engineering features of the canal problem, it may be stated that the geologic examination of the route, including the boring, has resulted, in nearly every case, in showing that conditions are more favorable than they had previously been assumed. In the few cases in which less favorable conditions were found modifications in the plans suggested themselves by which the unfavorable conditions are avoided.

Thus the project, which has repeatedly been pronounced feasible by eminent engineers, is placed in a still stronger position by the most exacting scientific tests.

C. Willard Hayes.

U. S. Geological Survey, July, 1899.

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*TRANSPARENCY AND OPACITY.**

One kind of opacity is due to absorption; but the lecture dealt rather with that de-

* Abstract of a lecture given by Lord Rayleigh before the Royal Institution of Great Britain.

ficiency of transparency which depends upon irregular reflexions and refractions. One of the best examples is that met with in Christiansen's experiment. Powdered glass, all from one piece and free from dirt, is placed in a bottle with parallel flat sides. In this state it is quite opaque; but if the interstices between the fragments are filled up with a liquid mixture of bisulphide of of carbon and benzole, carefully adjusted so as to be of equal refractivity with the glass, the mass becomes optically homogeneous, and therefore transparent. In consequence, however, of the different dispersive powers of the two substances, the adjustment is good for one part only of the spectrum, other parts being scattered in transmission much as if no liquid were employed, though, of course, in a less degree. The consequence is that a small source of light, backed preferably by a dark ground, is seen in its natural outlines, but strongly colored. The color depends upon the precise composition of the liquid, and further varies with the temperature, a few degrees of warmth sufficing to cause a transition from red through yellow to green.

The lecturer had long been aware that the light regularly transmitted through a stratum of 15 to 20 mm. thick was of a high degree of purity, but it was only recently that he found, to his astonishment, as the result of a more particular observation, that the range of refrangibility included was but two and a half times that embraced by the two D-lines. The poverty of general effect, when the darkness of the background is not attended to, was thus explained; for the highly monochromatic and accordingly attenuated light from the special source is then overlaid by diffused light of other colors.

More precise determinations of the range of light transmitted were subsequently effected with thinner strata of glass powder contained in cells formed of parallel glass. The cell may be placed between the prisms of the spectroscope and the object glass of the collimator. With the above-mentioned liquids a stratum 5 mm. thick transmitted, without appreciable disturbance, a range of the spectrum measured by 11.3 times the interval of the D's. In another cell of the same thickness an effort was made to reduce the difference of dispersive powers. To this end the powder was of plate glass and the liquid oil of cedar-wood adjusted with a little bisulphide of carbon. The general transparency of this cell was the highest yet observed. When it was tested upon the spectrum the range of refrangibility transmitted was estimated at 34 times the interval of the D's.

As regards the substitution of other transparent solid material for glass the choice is restricted by the presumed necessity of avoiding appreciable double refraction. Common salt is singly refracting, but attempts to use it were not successful. Opaque patches always interfered. With the idea that these might be due to included mother liquor, the salt was heated to incipient redness, but with little advantage. Transparent rock-salt artificially broken may, however, be used with good effect, but there is some difficulty in preventing the approximately rectangular fragments from arranging themselves too closely.

The principle of evanescent refraction may also be applied to the spectroscope. Some twenty years ago an instrument had been constructed upon this plan. Twelve 90° prisms of Chance's 'dense flint' were cemented in a row upon a strip of glass, and the whole was immersed in a liquid mixture of bisulphide of carbon with a little benzole. The dispersive power of the liquid exceeds that of the solid, and the difference amounts to about three-quarters of the dispersive power of Chance's 'extra dense flint.' The resolving power of the latter glass is measured by the number of centi-

meters of available thickness, if we take the power required to resolve the D-lines as unity. The compound spectroscope had an available thickness of 12 inches or 30 cm., so that its theoretical resolving power (in the yellow region of the spectrum) would be about 22. With the aid of a reflector the prism could be used twice over, and then the resolving power is doubled.

One of the objections to a stereoscope depending upon bisulphide of carbon is the sensitiveness to temperature. In the ordinary arrangement of prisms the refracting edges are vertical. If, as often happens, the upper part of a fluid prism is warmer than the lower the definition is ruined, one degree (Centigrade) of temperature making nine times as great a difference of refraction as a passage from D_1 to D_2. The objection is to a great extent obviated by so mounting the compound prism that the refracting edges are *horizontal*, which, of course, entails a horizontal slit. The disturbance due to a stratified temperature is then largely compensated by a change of focus.

In the instrument above described, the dispersive power is great—the D-lines are seen widely separated with the naked eye—but the aperture is inconveniently small ($\frac{1}{2}$-inch). In the new instrument exhibited, the prisms (supplied by Messrs. Watson) are larger, so that a line of ten prisms occupies 20 inches. Thus, while the resolving power is much greater, the dispersion is less than before.

In the course of the lecture the instrument was applied to show the duplicity of the reversed soda lines. The interval on the screen between the centers of the dark lines was about half an inch.

It is instructive to compare the action of the glass powder with that of the spectroscope. In the latter the disposition of the prisms is regular, and in passing from one edge of the beam to the other there is complete substitution of liquid for glass over the whole length. For one kind of light there is no relative retardation, and the resolving power depends upon the question of what change of wave-length is required in order that its relative retardation may be altered from zero to the quarter wave-length. All kinds of light for which the relative retardation is less than this remain mixed. In the case of the powder we have similar questions to consider. For one kind of light the medium is optically homogeneous, *i. e.*, the retardation is the same along all rays. If we now suppose the quality of the light slightly varied, the retardation is no longer precisely the same along all rays; but if the variation from the mean falls short of the quarter wave-length it is without importance, and the medium still behaves practically as if it were homogeneous. The difference between the action of the powder and that of the regular prisms in the spectroscope depends upon this, that in the latter there is complete substitution of glass for liquid along the extreme rays, while in the former the paths of all the rays lie partly through glass and partly through liquid in nearly the same proportions. The difference of retardations along various rays is thus a question of a deviation from an average.

It is true that we may imagine a relative distribution of glass and liquid that would more nearly assimilate the two cases. If, for example, the glass consisted of equal spheres resting against one another in cubic order some rays might pass entirely through glass and others entirely through liquid, and then the quarter wave-length of relative retardation would enter at the same total thickness in both cases But such an arrangement would be highly unstable, and if the spheres be packed in close order the extreme relative retardation would be much less. The latter arrangement, for which exact results could readily be calculated, represents the glass powder more nearly than does the cubic order.

A simplified problem in which the element of chance is retained may be constructed by supposing the particles of glass replaced by thin parallel discs which are distributed entirely at random over a certain stratum. We may go further and imagine the discs limited to a particular plane. Each disc is supposed to exercise a minute retarding influence on the light which traverses it, and they are supposed to be so numerous that it is improbable that a ray can pass the plane without encountering a large number. A certain number (m) of encounters is more probable than any other, but if every ray encountered the same number of discs the retardation would be uniform and lead to no disturbance.

It is a question of probabilities to determine the chance of a prescribed number of encounters, or of a prescribed deviation from the mean. In the notation of the integral calculus the chance of the deviation from m lying between $\pm r$ is *

$$\frac{2}{\sqrt{\pi}} \int_0^{\tau} e^{-\tau^2} d\tau,$$

where $\tau = r / \sqrt{(2m)}$. This is equal to ·84 when $\tau = 1{\cdot}0$, or $r = \sqrt{(2m)}$; so that the chance is comparatively small of a deviation from m exceeding $\pm \sqrt{(2m)}$.

To represent the glass powder occupying a stratum of 2 cm. thick we may perhaps suppose that $m = 72$. There would thus be a moderate chance of a difference of retardations equal to, say, one-fifth of the extreme difference corresponding to a substitution of glass for liquid throughout the whole thickness. The range of wave-lengths in the light regularly transmitted by the powder would thus be about five times the range of wave-lengths still unseparated in a spectroscope of equal (2 cm.) thickness. Of course, no calculation of this kind can give more than a rough idea of the action of the powder, whose disposition, though partly a matter of chance, is also influenced by mechanical considerations; but it appears, at any rate, that the character of the light regularly transmitted by the powder is such as may reasonably be explained.

As regards the size of the grains of glass it will be seen that as great or a greater degree of purity may be obtained in a given thickness from coarse grains as from fine ones, but the light not regularly transmited is dispersed through smaller angles. Here, again, the comparison with the regularly disposed prisms of an actual spectroscope is useful.

At the close of the lecture the failure of transparency, which arises from the presence of particles, small compared to the wave-length of light was discussed. The tints of the setting sun were illustrated by passing the light from the electric lamp through a liquid in which a precipitate of sulphur was slowly forming.* The lecturer gave reasons for his opinion that the blue of the sky is not wholly, or even principally, due to particles of foreign matter. The molecules of air themselves are competent to disperse a light not greatly inferior in brightness to that which we receive from the sky.

R.

* See *Phil. Mag.* 1899, Vol. XLVII., p. 251.

DISTRIBUTION OF THE KEEWATIN IN MINNESOTA.

IN Minnesota the lithological characters of that part of the Algonkian known as Lower Huronian or Keewatin are necessary in the recognition of the stratigraphic subdivisions of geographically separated localities. The Keewatin carries the first clearly defined sediments of this portion of the globe. Often the clastic origin of the rocks has been so completely obliterated by alteration due largely to dynamic metamorphism that it is difficult to distinguish them from their associates. At the bottom of the series is usually a quartzite which is locally con-

* Op. cit., 1881, Vol. XII., 96.

glomeratic and not infrequently a quartz— to mica-schist in petrographic habit.

The following are the localities of accepted Keewatin: 1. Lake of the Woods district. Four ridges corresponding to as many upward folds of the Archean contain in the troughs between them the softer mica-schists, chlorite-schists, agglomerates, etc., of the Keewatin. [Compare Lawson, Geol. and Nat. Hist. Sur. Can. 1885, cc., pp. 10–22.] On the Minnesota side of the lake there is less opportunity for study; it is probable that not all three intervening depressions will be found south of the international boundary. 2. Along Rainy River and in the Rainy Lake region a double trough formed by the earlier rocks contains the Lower Huronian series. While the rocks consist largely of volcanics now altered to hornblende—and hornblendic schists, there are also fissile glossy schists, carrying water-worn pebbles, breccias, graywackes, etc. The Lower Huronian rock exposures of the northern Rainy Lake basin can be traced in direct continuity into the rocks in the Lake of the Woods district already noted. [Lawson, Amer. Jour. Sci. 1887, vol. 133, pp. 477, 478.] In 1894 H. V. Winchell and U. S. Grant carefully mapped this region and described a belt of Keewatin "conglomerates, slates, sericitic, chloritic and hornblendic schists, agglomerates, graywackes and more or less altered igneous rocks, both acid and basic." The most important belt enters Minnesota between Rainy Lake City and the north shore of Jackfish Bay. The general direction of this belt is W. 15°–20° S., according to the map referred to, the greater part of the area in view lying within Ontario. Many of the gold locations around Rainy Lake lie in the Keewatin rock areas. [Prelim. Rep. on Rainy L. gold region 23d Ann. Rep. Geol. and Nat. Hist. Sur. Minn., 1895, pp. 36–104.] 3. The most eastern of the successive belts of Keewatin rocks extending from Ontario into Minnesota is that in exposure along the boundary between the head of Basswood Lake and Lake Saganaga, with Knife Lake as a sort of axis. This belt, followed in a W., S. W. direction, becomes effectually covered by glacial drift a short distance beyond Vermilion Lake. Two or three exposures are reported from near the Mississippi River. The rocks are conglomerates, sericitic schists, more or less altered eruptives and the remarkable segregations of hematite mined between Tower and Ely and occurring in what have thus far proved leaner deposits eastward, possibly into the Kaministiquia district of Ontario. Economically this is the most important Keewatin area in Minnesota thus far explored.

In the eastern and central portions of the State are rocks hitherto not generally regarded as Keewatin: 4. Several areas may be grouped: (*a*) At Thomson, Carlton and southwestward lies an extensive mass of quartzose clastics in which occur lenses or beds of slate regarded by Irving and N. H. Winchell as Animiké; locally they are conglomeratic. (*b*) Around Barnum and Moose Lake lies a series of hornblende-biotite schists dipping at a low angle southward; the texture is rather fine and the general aspect of the rocks fresh and sharply crystalline. (*c*) West of Sturgeon Lake lies a belt of hornblende schists dipping at a high angle or standing vertical with interleaved granitic, gneissic and quartzose masses. These schists are, in places, garnetiferous and frequently abound in lenses and stringers of quartz. (*d*) Still farther southwestward, on the Kettle River, are exposures of mica schists with veins and dikes of granite within the schists, while (*e*) at Ann River and westward through Mille Lacs, Benton, Sherburne and Stearns counties are enormous masses of hornblende-biotite granite. These granites in their freshest condition carry augite cores within

the hornblende-biotite areas and in several localities are in apparent proximity to gabbro. (*f*) Farther north, on the Mississippi River, from Two Rivers past Little Falls to the valley of the Elk River, are extensive exposures of a fine-grained hornblende-biotite schist carrying bosses of gabbro and lenses of quartz-diorite [J. H. Kloos, Neu. Jahrb. für. Min., 1877, S. 225] and, also locally, thickly studded with staurolite crystals and garnets. (*g*) Finally the interesting masses of epidote granite and associated basic eruptives of Western Stearns, Todd and Cass counties.

I have reached the conclusion that all the areas enumerated under (*a*) to (*g*) above belong to the same geologic time division, viz., the Keewatin. The clastics, partially altered clastics and thoroughly crystalline schists in the areas (*a*), (*b*), (*c*), (*d*) and (*f*) belong to a single rock series and the granites and gabbros of areas (*d*), (*e*), (*f*) and (*g*) are eruptive through them. The staurolite, garnet, quartz-lenses, etc., essentially contact minerals, bear circumstantial evidence of the proximity of eruptive masses of granite or gabbro even where such masses are not now seen owing to enormous subsequent erosion or the covering of glacial drift.

Among the considerations upon which the foregoing conclusion was reached are the following: 1. The quartzose clastics and hornblende-biotite schists, which are admittedly one and the same rock series [Irving, R. D., Fifth An. Rep. Director U. S. Geol. Sur., p. 196], can be traced by petrographic and structural characters through Mahtowa, Barnum and Moose Lake in an almost continuous succession of exposures from the Thomson conglomerate to the coarser garnetiferous schists, carrying quartz stringers and lenses in considerable profusion west of Sturgeon Lake; and these in turn through reported exposures [Hopewell Clarke, Land Commissioner, St. Paul and Duluth R. R.] to the Snake River valley schists filled with dikes of granite. 2. The relation of the Snake River granite dikes in T. 42, R. 23 W., and the granites of Kanabec, Mille Lacs, Benton, Sherburne and Stearns counties cannot be traced in the field, yet their petrographic characters are essentially alike, and they have always been assumed to be the same. 3. The staurolite-bearing southern border of the Mississippi Valley schists disappears beneath the glacial drift in striking nearness to the granites of Stearns and Morrison counties. 4. Nowhere in Minnesota has this type of granite been found intrusive into or through the Animiké [for illustration compare Irving, R. D., Seventh An. Rep. Director U. S. Geol. Sur., pp. 421, 422]; in several places in central North America it is reported as penetrating and lying upon the Keewatin [*e. g.*, Lawson, A. C., Geol. and Nat. Hist. Sur. Can., 1885, cc., p. 14].

Summarizing: The Keewatin of Minnesota, therefore, occupies a much greater area than has hitherto been assigned to it, since it underlies the large central region of the State. It here consists of two distinct rock groups, one a clastic-crystalline and the other an eruptive, partly acid and partly basic, breaking into and through the former. The two exhibit in places a typical eruptive unconformity, yet volcanic activity apparently ceased before overlying rocks were laid down upon the intermingled eruptive and clastic material.

The hornblende-biotite granites of central Minnesota constitute enormous erupted masses, probably laccolitic in structure, which towards the northeast give place to a system of dikes which break through the schists and cause the greatest stratigraphic confusion. It is in this region that the schists become thickly studded with contact minerals.

The succession of characters representing

the transition of a clastic rock into a schist, and the loading of the schist with accessory minerals in the vicinity of the intruding eruptives, is identical with what can be seen in the Black Hills, and described for the same region by Van Hise [Bull. Geol. Soc. Am., Vol. I., pp. 209–211]. The metasomatic changes of the quartz clastics to crystalline schists in Minnesota is a process identical with what has been so fully discussed for the Penokee Range of Wisconsin [Van Hise, Amer. Jour. Sci., Vol. 131, pp. 453–459] and recognized in other localities too numerous to cite.

C. W. Hall.

University of Minnesota.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The thirteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held at San Francisco, July 5th–7th, in conjunction with the Association of Official Agricultural Chemists. Delegates from 34 States and Territories were in attendance. The welcome of the city was voiced by Mayor Phelan, and many courtesies were extended the visitors by individuals and associations representing the State of California. Especial mention should be made of the untiring efforts of Professor M. E. Jaffa, of the University of California, to facilitate the business of the convention and secure the personal comfort of the delegates.

Dr. H. P. Armsby, director of the experiment station connected with the Pennsylvania State College, presided at the general sessions and delivered the President's annual address. This was a clear and forcible presentation of the central purpose of the experiment stations as institutions of higher education. By original research they are to increase our knowledge of the principles underlying the art of agriculture and show the farmer how these may be applied to the advantage of his practice. The station should be the source of knowledge and inspiration for the agricultural college—the cap-stone of agricultural education. As such it should be divorced as far as possible from the routine elementary instruction of the college. At its head should be a director who inspires rather than directs.

By appointment President M. H. Buckham, of the University of Vermont, pronounced a graceful and discriminating eulogy on Senator Justin S. Morrill and introduced memorial resolutions which were unanimously adopted. In discussing Senator Morrill's relation to the great educational measures with which his name will always be connected, President Buckham said that the central idea which the great statesman intended to embody in this legislation was that it was possible by a suitable form of higher education to lift the arts and industries to the plane hitherto occupied alone by the professions. This the speaker claimed was a unique American idea, and its practical crystallization in the Morrill Acts of 1862 and 1890 placed them among the epoch-making acts of the American Congress.

The fourth report of progress of the Committee on Methods of Teaching Agriculture was read by Director A. C. True, secretary of the committee. This report presented a syllabus of a course in zootechny which was limited to the theory and practice of the production of the normal useful animal. Zootechny was divided by the committee into three main branches: (1) types and breeds of useful animals; (2) feeding, and (3) hygiene and management. It was deemed most feasible that the teaching of the general principles under each one of these heads should be immediately followed by the application of the principles to practice as regards different kinds of ani-

mals. The committee, however, conceded that there were important pedagogical reasons favoring the teaching of the principles of zootechny as a whole before proceeding to discuss their practical application to the art of animal husbandry. Explanation was also made of the general considerations which had governed the committee in constructing its syllabi for both agronomy and zootechny. An interesting discussion followed this report, in which some of the difficulties in separating instruction in technical agriculture from that in agricultural chemistry, economic botany, soil physics and other related sciences were pointed out. The committee was continued, and hopes during the next year to complete its outline of the college course in agriculture, by making syllabi for the courses in agrotechny, rural engineering and rural economics.

The absorbing interest which the Association takes in questions relating to the improvement of courses and instruction in agriculture and mechanic arts was further shown by the relatively large number of papers on these subjects read and discussed at this meeting. Such were the papers on the principles which should underlie the formation of a course in agriculture, by Dr. C. E. Coates, Jr., of Louisiana; the short dairy course, by Professor W. J. Spillman, of Washington; horticultural education in Minnesota, by Director W. M. Liggett, of Minnesota; university extension in agriculture, by President J. H. Raymond, of West Virginia; the teaching of machine design, by J. T. Faig, of Kentucky; the agricultural engineer—the latest developed specialist, by W. T. Magruder, of Ohio; some objections to early differentiation of engineering courses by J. C. Nagle, of Texas; and teaching methods in the mechanic arts, by H. Gwinner, of Maryland.

The most largely attended section was that on Agriculture and Chemistry. This was due in large measure to the program, which included subjects of vital importance to the West. These in general related to alkali soils, irrigation, and the range feeding of cattle. In the absence of Professor Hilgard, Professor R. H. Loughridge, of California, discussed the alkali soils of the Pacific coast and their utilization, showing the nature of 'white' and 'black' alkali and the means adopted by the California Station for the reclamation of alkali lands. The problems related to similar lands in New Mexico, Montana and Wyoming were respectively described by Professors A. Goss, F. W. Traphagen and B. C. Buffum. Some interesting work of the Wyoming Station relating to the effects of alkali on the germination of seeds was described by Professor Buffum. Irrigation problems in the West were outlined by Professor L. G. Carpenter, of Colorado, who illustrated his remarks with interesting charts showing the economy and waste in the use of irrigation water in practice on different farms. The work in irrigation lately undertaken by the Department of Agriculture was explained by Director True and Professor Elwood Mead, the irrigation expert in charge of these investigations. Professor E. J. Wickson, of California, told some of the facts learned from practice in the use of irrigation for orchard fruits. He urged that irrigation showed beneficial results not only in the increased vigor and productiveness of the trees, but in the improved appearance and quality of the fruit.

On the range feeding of cattle papers were presented by Professors W. W. Cooke, of Colorado; C. D. Smith, of Michigan, and H. T. French, of Idaho. The latter contended that his experience indicated that range steers could be conveniently and profitably fattened for market by stall feeding following that on the range. Mr. V. K. Chesnut, of the Division of Botany, Department of Agriculture, aroused consider-

able interest by his paper on plants poisonous to stock, a subject which is receiving attention at several of the Western stations.

In the section on Horticulture and Botany Mr. Alexander Cran, quarantine officer of the California State Board of Horticulture, read a paper on the inspection of nursery stock and orchards, which was followed by considerable discussion of the methods used in this work. Professor A. J. McClatchie, of Arizona, described the methods of irrigation used in orchards. Papers on 'Seed Testing,' by A. J. Pieters, of the Division of Botany, Department of Agriculture, and the 'Climatology of Horticulture,' by Professor E. J. Wickson, were read before the general session of the Association on the recommendation of the section. The latter was a suggestive paper expressing a hope that the relation of climate to the production of horticultural plants might ere long receive serious attention in this country.

The increasing importance of cooperation between the Department of Agriculture and the experiment stations attracted the attention of the Association, and a committee was appointed to consider the basis and methods of such cooperation and report at the next meeting.

The Executive Committee was instructed to endeavor to secure some arrangement by which public documents might be more promptly and satisfactorily delivered to the libraries of the institutions entitled to receive them, and also to obtain a place on the program of the next meeting of the National Education Association for a paper on the mission of the land-grant colleges in our American system of education.

Much interest was manifested in the announcement of the arrangement recently made by the Secretary of Agriculture with the Civil Service Commission under which it is proposed to admit a limited number of the graduates of the land-grant colleges to the Department of Agriculture at a nominal salary as 'scientific aids.' Vacancies in the Committee on Graduate Study at Washington were filled, and it is expected that this committee will continue to promote the plans of the Association for the establishment of a bureau of graduate study at the National capital.

The following officers of the Association for the ensuing year were elected:

President, J. E. Stubbs, of the University of Nevada; Vice-Presidents, E. W. Hilgard, of the University of California; J. M. Stone, of the Agricultural College of Mississippi; E. E. Smiley, of the University of Wyoming; M. H. Buckham, of the University of Vermont, and M. A. Scovell, of the Experiment Station of Kentucky; Secretary-Treasurer, E. B. Voorhees, of the Experiment Station of New Jersey; Bibliographer, A. C. True, of the Department of Agriculture. Executive Committee, H. H. Goodell, of the Massachusetts Agricultural College; W. M. Liggett, of the Universiity of Minnesota; J. H. Washburn, of the Agricultural and Mechanical College of Rhode Island, and Alexis Cope, of the University of Ohio.

Officers of Sections: College Work—J. K. Patterson, of Kentucky, Chairman; A. W. Harris, of Maine, Secretary. Agriculture and Chemistry—L. G. Carpenter, of Colorado, Chairman; C. D. Woods, of Maine, Secretary. Horticulture and Botany—L. A. Beach, of New York, Chairman; P. H. Rolfs, of South Carolina, Secretary. Mechanic Arts—C. S. Markland, of New Hampshire, Chairman; F. P. Anderson, of Kentucky, Secretary.

The day succeeding the adjournment of the convention was spent in visiting the University of California, and the following week was occupied in excursions to the principal agricultural and horticultural sections of central California. These excur-

sions, freely provided for the entertainment of the two Associations by the railroads and citizens of California, were much appreciated by the delegates, who were thus enabled to learn many important things regarding the wonderful natural resources and industrial development of California, which the ordinary tourist does not become acquainted with.

A. C. TRUE.

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*INTERNATIONAL CONFERENCE ON HYBRIDIZATION.**

AT the Royal Horticultural Society's gardens at Chiswick, on July 11th, an International Conference was opened for the purpose of discussing 'Hybridization and the Cross-breeding of Varieties.' There were present representatives of the government of the United States and of most of the European countries, besides a large number of British hybridists and botanists. An interesting and unique exhibition of plants and flowers had been arranged in the vinery. All the exhibits were received under condition that they were 'a new species or new variety.' Most of the plants bore a card which stated the name of the hybrid or cross-bred, the name of the female or seed parent, the name of the male or pollen parent, and remarks on variation, size, form and color. Sir Trevor Lawrence, the President of the Royal Horticultural Society, welcomed the members of the Conference, and mentioned that the King of the Belgians had conferred upon Dr. Maxwell Masters, F.R.S., who later on took the chair at the Conference, the insignia of an officer of the Order of Leopold.

At the sitting of the Conference Dr. Maxwell Masters, in opening the proceedings, gave an address on the history of hybridization. He said they had met to discuss the most important problem of modern progress in experimental horticulture. Apart from scientific experimental horticulture he did not think that they had progressed at all, as far as the practical details of cultivation were concerned, beyond what their forefathers had done. But when they came to scientific experimental work their forefathers were nowhere. If they went into present-day gardens they found that nine-tenths of the plants were the productions of the gardener's art, and not natural productions. There was a time when they took an interest in new plants introduced from the tropics and elsewhere; but now the Horticultural Society's flower shows at the Drill-hall, Westminster, did not produce anything new more than once or twice in a year. The so-called new plants now exhibited were the products of the gardener's art. Referring to the discussions in the early part of the 18th century as to the question of sexes in plants, he said that the first person in this country or any other who formed an artificial hybrid purposely—many people must have produced them unconsciously before that time—was Thomas Fairchild, who must be known to many people as the originator of the flower sermons now so common in many churches. The hybrid which he produced was a cross between a sweet william and a carnation pink, and something very much like it was still in existence. From that time, however, progress was slow until Linnæus was struck with the same phenomenon; while Thomas Andrew Knight, a former President of the Royal Horticultural Society, and Dean Herbert were celebrated for their work in the same direction. In their day there was a great prejudice against hybridization among certain religious people. It was said that by the cross-breeding of plants people were flying in the face of Providence and that the process was wicked. But Dean Herbert showed that by crossing two species of daffodils which he found on the Pyrenees he could produce

*From reports in the London *Times*.

flowers similar to those which abounded in that locality; and he, therefore, argued that if Nature did the same thing he must not be blamed for doing what Nature did. The prejudice against hybridization was carried so far that nurserymen were afraid to exhibit hybrid plants in the Royal Horticultural Society's gardens, because they might injure the feelings of some over-sensitive religious persons; and they, therefore, exhibited them as wild species from abroad. Dean Herbert did much to break down that prejudice. They now had to meet a prejudice of another kind, of which he felt ashamed. He meant the prejudice which existed in the minds of some botanists against hybridization. He could understand how vexed botanists were to find their pretty little systems upset by the proceedings of hybridists. But he thought it was far preferable to uphold the interests of science and truth than of their petty systems. After referring to Darwin's views on species, he said that the question of species, as they understood it, was merely an individual opinion, and that there was no dividing-line between species, varieties and genera. And as to crossing between species not being hybridizing, as some persons asserted, he said that they desired to deal with hybridization in its widest sense, in the full confidence by so doing they would be not only advancing science, but also adding enormously to the welfare of humanity.

Papers were then read on 'Hybridization and Cross-breeding as a Method of Scientific Investigation,' by Mr. W. Bateson, F. R. S., Cambridge; 'Hybridization as a Means of Pangenetic Infection,' by Professor Hugo de Vries, Amsterdam; 'Hybridization and its Failures,' by the Rev. Professor George Henslow, London; 'Progress of Hybridization in the United States of America,' by Professor L. H. Bailey, Cornell University, U. S. A.; and 'Experiments in Hybridization and Cross-breeding,' by Mr. C. C. Hurst, Burbage, Hinckley.

The chair was taken by Professor G. Henslow on July 12th, who, in his opening remarks, said that these meetings were of great value, because they connected together scientific and practical work. The questions dealt with applied not only to hybridization, but also to all parts of botany; and botanists would be only too thankful to get hold of facts with which the horticulturist was familiar.

Mr. Herbert J. Webber, from the United States Department of Agriculture, gave an interesting lecture, with lantern demonstration, on the work of his department in plant hybridization. He said that the work of hybridizing was started not more than three years ago, and the results attained were far from complete. All the plants on which they had worked were, in the main, horticultural products of America, and one of the principal was the orange plant. A few years ago almost the entire orange industry for a season in Florida was destroyed by frost in a single night, and about a hundred million dollars was lost by the damage done. In consequence of this they arrived at the conclusion that either they must abandon the orange industry in Florida or secure a variety of orange which was very much hardier and which would resist the frost. Accordingly, they set to work to hybridize the Japanese orange, *Citris trifoliata*, with the sweet orange. The *trifoliata* was found as far north as New York, and was used as a hedge plant. The fruit was bitter and resinous, and was used as a preserve fruit; but the plant was hardy in character, and by hybridizing it with the common sweet orange it was hoped that the frosts would be resisted and that they might obtain hybrids of the two species and a deciduous as well as an evergreen orange. After illustrating the new plants by means of the

lantern, Mr. Webber said that the true hybrid plants had been found very much more vigorous than the common sweet orange. His department had also made experiments with the view of combining the character of the tangerine with the common orange in order to secure, if possible, the loose skin of the tangerine with the common variety. The sweet orange was of much better quality and more desirable than the tangerine, but if by hybridizing they could produce a fruit to combine the characters of the two he thought that such a fruit would take the market; and they were working on those lines. They were further endeavoring to improve the quality of the orange by crossing the bitter-sweet pomelo with the sweet orange. He gave illustrations of the different foliage and developments of the plants brought about by hybridizing. The United States Agricultural Department had, he said, also been working more or less with pineapples; and he pointed out that it had been ascertained that by the crossing of fruits which were commonly seedless they could frequently produce seeds, and that the plants so dealt with were more vigorous and better able to resist disease. Another branch of their work was with cotton plants, the main point being to hybridize between the Upland cotton and the so-called Sea Island cotton. The improvements obtained Mr. Webber illustrated by means of the lantern slides, and said that by this hybridization they hoped to extend the cotton industry considerably. The last experiment dealt with by the lecturer was the hybridization of corn (maize) by introducing the wild species into the cultivated strain. They were endeavoring to cross the common maize with the wild Mexican grass Theosinth, which was supposed to be the progenitor of maize; but, of course, there must be numerous generations before they could bring out the character of the corn to any great effect.

The following papers were also read: 'The Structure of certain New Hybrids (Passiflora, Albuca, Ribes, Begonia, &c.),' with lantern demonstration, by Dr. J. H. Wilson, St. Andrews; 'Hybridization viewed from the standpoint of Systematic Botany,' by Mr. R. Allen Rolfe, Kew; 'Hybrid Poppies,' by M. Henry de Vilmorin, Verrieres; 'Self-Fertilization of Plants,' by M. Lemoine, Nancy; 'Hybrid and Cross-bred Fruits,' by Mr. Luther Burbank, San Rosa, California, U. S. A.; and Mr. T. Francis Rivers, Sawbridgeworth.

The festival dinner of the Conference was held at the Whitehall Rooms, Sir Trevor Lawrence presiding. The toast of 'The Queen, Patron of the Society,' having been honored, the Rev. Professor Henslow proposed 'Horticulture,' and Mr. H. J. Webber, in responding, said he brought with him the friendly greeting of the United States Secretary of Agriculture. He added that he hoped to see the time when the originator of a new fruit or flower, in addition to the satisfaction he might feel in conferring a benefit on humanity, would receive the just and practical recompense to which he was entitled. Professor Hugo de Vries (Amsterdam University) and M. Henry de Vilmorin also responded. Mr. Bateson proposed the toast of 'Hybridists,' Mr. W. T. Swingle (Washington) responding. The Master of the Rolls gave 'The Royal Horticultural Society,' and referred to the early work of the Society in sending out investigators into various parts of the world. The Chairman, in reply, said it was owing to the work of Robert Fortune, who was sent by the Society into China, that the cultivation of the tea plant was introduced into India and Ceylon and an immense trade was thus almost wholly transferred from China. The Society, which was founded in 1804, would soon have to consider how it was to celebrate its century. Of late years the Society had been progress-

ing by leaps and bounds, but it needed a hall in London and a new garden in place of the old garden at Chiswick. The Belgian Minister responded for the visitors.

SCIENTIFIC BOOKS.

German Higher Schools: the History, Organization and Methods of Secondary Education in Germany. JAMES E. RUSSELL, PH. D., Dean of Teachers College, Columbia University. New York, London and Bombay, Longmans, Green & Co. 1899.

The magnificent spectacle of German education is something which it is of extreme importance for our own progress, as well as of great interest as an intellectual phenomenon, that we should thoroughly understand. Nothing that has hitherto appeared on the subject is to be compared for comprehensiveness of character or for vividness of presentation with this work of the Dean of the Teachers College of New York. If all works on education were as interesting as this the science of pedagogy would not be the dreary burden which it is now to most persons of any spirit or of any feeling for logical structure. And if the science of pedagogy had more frequently proved attractive to the better order of writers, who knows how much farther advanced the art and practice of teaching might have been than it now is?

Mr. Russell has been European Commissioner of the Regents of the University of the State of New York, and special agent of the Bureau of Education for the study of German schools. He has thus had unusual opportunities for carrying out his investigations; school officials, high and low, have given him generously of their time, and have put him in the way of comprehending the spirit and the ideals of their educational system. The five years that he has devoted to the subject have been put to good use, and their product is a book of an unusual degree of value. We can only touch upon a few of the more striking characteristics of the German system of education as here depicted.

Of first importance, and far more striking than anything that is said in regard to the system of instruction, is the preparation to which the German teacher must be subjected before he can enter upon his career. It should be premised that there are no exceptions in Germany, and that these regulations must be complied with by absolutely every one who proposes to become a teacher in a higher school. After his nine years' course in a gymnasium the candidate for this profession enters the University, where his studies can nominally be completed in three years, but where, as matter of fact, he is sure to spend from four to five years of hard work. He then presents himself for the State examination, the sole test of a candidate's preparation for any professional career, which neither the degree of Doctor of Philosophy nor any other scholarly distinction can enable him to dispense with. The examining board (consisting chiefly of university professors) he must satisfy (1) of his proficiency in pedagogy and philosophy, including psychology, logic and ethics; (2) of his familiarity with the German language and literature; (3) of his acquaintance with the doctrines of religion, and (4) of his thorough knowledge of the special subjects which he expects to teach. These latter subjects must be at least four in number, two major and two minor, and he must never presume to teach any subject in which he has not received a certificate, nor to any extent beyond that corresponding to the grade of his certificate—first, second or third. (There are certain restrictions limiting his combination of subjects; for example, with any grade of French or English, he must have at least third grade Latin, and if one of his majors is religion the accompanying one must be Hebrew.) As a general thing, the future teacher does not take the degree of Ph. D. at his university; that is a luxury costing from one to two hundred dollars, besides the time spent in the preparation of a thesis; and the Staats-Examen is regarded as more of a distinction than that leading to the degree, besides being, in any case, obligatory. The application for examination is itself a serious affair. There is a fee of thirty marks to be paid for each examination; then there are certificates and testimonials to be furnished of the candidate's whole course of preparation, showing precisely what he has done and what his standing has been during his whole school life from the age of nine years; then there is

his *Vita*, in which the candidate tells when he was born, the rank or occupation of his father, his religious adherence, etc.; this is to be written in Latin if his subjects are the classical languages, and in French or English if they are the modern languages. His application is not regarded as satisfactory if the commissioners are left in any doubt as to his moral character, or if they suspect him of being disloyal in either religion or politics. But after all these requirements have been met, and the examination has been successfully passed, the candidate is by no means ready to enter upon his profession; two years of purely pedagogical training must follow, first a year of study in a pedagogical seminary, and then a year of trial-teaching, under inspection. For this year of teaching he receives no remuneration, and if his work is not satisfactory he may, on the report of his director, be dismissed from the service. This last year of his preparation has brought him, counting in the one year of military service which he must have passed through, to the age of twenty-six at the very least, and more frequently he is two or three years older than that; having reached this stage his name is inscribed on the list of teachers eligible to appointment, and after a period of waiting, which lasts on the average from five to six years, he is at the end sure of an occupation for the rest of his life, and of a decent retiring pension at the close of his term of service.

In comparison with the easy-going methods which we are accustomed to in this country, all this looks like hardship in the extreme for the poor teacher. But what admirable provision it makes for the training of the coming scholar! With an educational system which is laid out on such a scale as this, it is no wonder that learning and research have their home in Germany, and that in industrial matters as well England and France have discovered that their supremacy is in imminent danger of passing away. The great pressure in Germany upon the means of subsistence, and in particular the extreme social prestige which attaches to the occupations which presuppose learning, and the social repression which is exerted upon those whose wealth is their only claim to recognition, have brought it about that the profession of teacher, whether in high school or in university, is one of extreme attractiveness; it follows from this that young men are willing to undergo long and expensive training for the privilege of entering it, and that the requirements can be made more and more exacting with only the result of securing better and better material. If a high civilization consists in a form of society in which the real things of life receive their rightful appreciation, in which an unselfish devotion to learning, to art, and to the discharge of the duties of public office is the quality above all others which is rewarded with the respect and honor of the whole community, then Germany may well claim to be at the present moment the most civilized nation upon the face of the earth. Certainly there is no other country where the art of securing the comforts, the artistic enjoyments, and, to a large extent, the elegances of life for a small expenditure of time and of money has been brought to such a state of perfection as here. This is largely, of course, because the Germans are free from the vulgar love of luxury and passion for display which the higher classes, that is, the intellectual classes, have not wholly succeeded in putting down in England and America; 'conspicuous consumption,' to use the happy characterization of Mr. Veblen, has not for them the baneful attractiveness which it has for the English and the Americans.

This is the bright side of the picture. The other and painful feature of intellectual life in Germany is that it is the possession of one-half of the population only; the women have thrown away the inheritance which should have been theirs from their splendid early German ancestors, and have sunk low in the abyss of household drudgery. The only way to effect a change in this sad state of things is to begin at the top; when it has once become not only possible, but a matter of course, for the clever woman to follow university courses, the standard as regards the proper consumption of time will be quickly raised throughout all ranks; professor's wives will no longer sit up all night to finish Christmas presents in worsted work as they do now, but will save their eyes for better uses. Great changes have been effected in

Germany during the past few years, and there are hardly any universities remaining which offer no facilities for the higher education of women, but these changes have been brought about by the courageous and energetic work of a few fair-minded professors, and in the face of the fanatical opposition of the great majority of them. "The boasted freedom of the universities is again contradicted in their attitude towards the education of women. No one expects the state to be liberal, but liberality is looked for in the highest educational centers of the country. But with what results? Determined, almost fanatical, opposition to the extension of university privileges to women * * * For those women who desire to secure a broader education than is afforded by the girls' schools, and who can easily enough take up university work and profit from it, there can be no valid reason for keeping them out. It makes one lose faith in the ideals of university enlightenment" (p. 416). Nevertheless, the first German woman has already taken the degree of Doctor of Philosophy at the University of Berlin, and in 1896 six young ladies of high social position, who had been trained by the enthusiastic and devoted Helene Lange, took the final examination set for the boys of a Berlin *Gymnasium*, and received high rank. "It will be seen," says Professor Russell, "that the woman question will soon supersede the Greek question" The crying need for women at present is the foundation of public *Gymnasia* for girls. In spite of several recent setbacks, progress can be safely predicted in this line. The latest news from Germany is that a *Gymnasium* for girls has been started in Hannover, and that the one in Karlsruhe, which has hitherto been in private hands, has been taken over by the city.

We have no space left for discussing German methods of teaching. The most important general difference between them and those which we know in this country is that less is left to the initiative of the scholar; he does much less of his work out of school hours, and the teacher takes a much more active part in the work of instruction. The joy and refreshment which the American boy gets out of his athletics are unknown to the German, but (what we are less in the habit of remembering) he has an immense resource in music, to which he gives a large part of his hours of recreation. As regards special studies, the account given of the new method in teaching modern languages is most illuminating, and gives record of marvellous results. But the whole book will become the useful companion of those who are interested in securing better and better systems in the education of the young.

Christine Ladd Franklin.
Baltimore.

The Native Tribes of Central Australia. By Spencer Baldwin, M.A., and F. J. Gillen. New York, Macmillan Co. 1899.

This work is an important contribution to Australian anthropology, being a careful monograph on the Arunta tribe, with observations on some neighboring tribes, giving an account of ceremonies, traditions, customs and myths As Mr. Cushing identified himself with Zuni Indians so the authors became initiated members of the Arunta tribe, and thus came into intimate knowledge of many facts of great interest, especially as throwing light on Totemic organization. The Totemic myths and ceremonies are treated in great detail. The Totem groups at the time of the year when rain may be expected and food animals breed, conduct simple ceremonies of chants of invitation, with representative plays which will insure the multiplying of the food. These ceremonies are essentially childish, are in the same spirit as the 'rain, rain, go away, come again another day' of civilized children. While these ceremonies do not appeal to supernatural beings, that is beings who are over rain, kangaroos, etc., but to the Rain, Kangaroo, etc., as themselves animate beings, yet as conciliatory the acts must be called religious, as coercive, unreligious, and the native mind continually vacillates from one to the other position. As to the origin of Totemism the authors (p. 127) can pronounce no opinion, yet (p. 209) the origin is sufficiently indicated as derived from the dominant food of any section of a tribe. With regard to such a Totem as Rain we see that the whole tribe have a general Rain dance, and the specialization of function is only partial to the Rain group (p. 193).

As to primitive marriage the authors tend toward a promiscuity theory as *versus* Westermarck (p. 111). It is notable that the 'muscle' dance as sexual lure is found amongst the Arunta (p. 381). Religion as mere craft is suggestively noted (p. 130). The intense solidarity and communism of savage life is vividly portrayed in this work. The account of socialization suggests that if we could penetrate animal organization, for example, crows, we might find quite similar methods, a general animistic interpretation and adaptation, and a sort of unspecialized Totemism, for instance, in rain calls. In this work we find plenty of hard dry facts, of external description, thorough and precise, but we have little large, comparative and psychic interpretation. We learn very little of how the natives think and feel. The conservatism of savage life is alluded to, as also the rather narrow but real chance of variation. Their powers of observation and memory in what directly concerns their livelihood is mentioned, as is also their very limited power of numeration. In adaptive intelligence they are in one point inferior to the elephant, who thatches himself, for though the Australian has warm skins of kangaroo he has never thought to use them as defense from the cold which often goes below freezing point. As clothing is unknown to him, we must revise our definition of man as an animal that wears clothes.

The authors are far from making clear the concept of the natives as regards the life of the individual after death. They continually use the word 'spirit'; but the essence or vital core of the individual which changes residence is really concrete (pp. 137 and 516), and it seems obvious that the natives have not risen to the idea of body and spirit. It would certainly be highly desirable that a skilled psychologist should closely interpret the psychic basis of the ceremonies, etc., described, should study emotions and their expressions, and test the psychic power of the natives in various ways.

The work has good maps and photographic illustrations. Some of the faces and figures are finely sculpturesque, for example pages 35 and 43, and the full face, p. 38, is a veritable Olympic Zeus.

HIRAM M. STANLEY.

Guide to Excursions in the Fossiliferous Rocks of New York State. By JOHN M. CLARKE, State Paleontologist. June, 1899. Pp. 1–120. Or Handbook 15, University of the State of New York.

This booklet is somewhat of a novelty in American geological literature. Every student of geology knows that New York State is classic ground for many of the Paleozoic formations of America. But a knowledge of how to see the various formations and collect their characteristic fossils to the best advantage in the shortest time and with the least expense can be obtained only after much experience. Here, however, most of this information is at hand and students of geology can go directly to classical localities and lovers of nature to some of the prettiest spots in the State.

In this booklet are described in detail 27 excursions, each demanding from 1 to 7 days. All of the trips can be made in from 56 to 72 days. The best and most readily accessible sections are described and directions given to railroads, the places to stop over night and the localities and beds furnishing characteristic fossils from the Cambrian to the Chemung, including the post-Glacial clays.

It is to be hoped that other States will profit by New York's example and that similar booklets for Maryland, Ohio, Indiana, Illinois and Iowa will follow. C. S.

BOOKS RECEIVED.

Praxis und Theorie der Zellen und B fruchtungslehre. VALENTIN HÄCKER. Jena, Gustav Fischer. 1899. Pp. viii + 260. Mark 7.

Physical Nature of the Child. STUART H. ROWE. New York and London, The Macmillan Company. Pp. xiv + 206. $1.00

The Elements of Physics for use in High Schools. HENRY CREW. New York and London, The Macmillan Company. 1899. Pp. xiii + 347. $1.10.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for July opens with an article by T. H. Montgomery, 'Observations on Owls, with particular regard to their Feeding Habits,' which clearly demonstrates the comparative abundance of small rodents as well as the numbers destroyed by owls.

Incidentally it shows with what regularity these birds resort to certain chosen roosting places. J. H. Comstock and J. G. Needham bring to a conclusion the fourth chapter on 'The Wings of Insects,' which treats of 'The Specialization of Wings by Addition,' and terminates that portion of the series devoted to furnishing data for determining the homologies of the veins. Arnold E. Ortmann discusses 'New Facts lately presented in opposition to the Bipolarity of Marine Faunas,' stating that they do not at all support the theory of bipolarity and that we must wait for further investigation to show whether bipolarity as a relic of older times is realized in the distribution of any marine animals. The first of the promised 'Synopses of North American Invertebrates,' by C. B. Davenport, is devoted to the 'Fresh-water Bryozoa.' A brief sketch of the habits and habitats of these animals is given, followed by a key for their specific determination and a bibliography of literature on Fresh-water Bryozoa. W. E. Praeger presents some 'Notes on the Habits of Bascanion Constrictor,' which contains good evidence as to the climbing abilities of this snake. Leonhard Stejneger, under the title 'A New Name for the Great Crested *Anolis* of Jamaica,' shows that there has been a curious unanimity in misnaming this reptile *Anolis edwardsii* and proposes for it the name of *Anolis garmani*.

The June number of the *Journal of the Boston Society of Medical Science* brings the third volume of this periodical to a close. The index shows that it contains sixty-five papers contributed by forty-five investigators. While there is a greater tendency towards pathological subjects than formerly, there is yet very much of interest to the comparative anatomist. In the present number Calvin G. Page has a 'Study of Streptococci isolated from Throat Cultures from Patients Ill with Scarlet Fever,' and a 'Preliminary Report on the Diplococcus of Scarlet Fever.' Theodore Hough and Bertha G. Ballantyne give a 'Preliminary Note on the Effects of Changes in External Temperature on the Circulation of Blood in the Skin,' and S. A. Hopkins presents a preliminary report on 'Bacteria and Dental Caries,' stating that he has not yet been able to deduce from his experiments any definite laws or positive results. Theobald Smith describes and figures 'Some Devices for the Cultivation of Anaërobic Bacteria in Fluid Media without the Use of Inert Gases.'

DISCUSSION AND CORRESPONDENCE.

ABOUT A REFORM IN NOMENCLATURE.

In the 'Nomenclator Zoologicus' of Scudder 80,000 genera are mentioned and there are 7,585 genera of phanerogamia. Human memory is unable to retain all these arbitrary names (languages have from 20,000 to 30,000 words each) and the result of it all is that "the language of science is more difficult than science itself." Even professed naturalists cannot guess what the *Mormops megalophylla* or the *Ceroplastes psidii* is. It is high time to repair this mischief by introducing the reform following:

1. The generic names of animals shall end in *us*, those of plants, in *a*, and those of minerals in *i*.

2. Minerals shall have a genus formed with the abbreviations of their components. Thus *Sulphurzinci sphalerita* indicates a mineral (i), a Sulphur (Sulph.) of zinc (zinci), of the species *sphalerita*.

3. Plants shall have their genus preceded by the abbreviation of their family. Thus *Rosaspiræa limbata* indicates a Rosacea (Rose), of the genus *spiræa* and the species *limbata*, plant (a).

4. The genus of animals shall be relegated to special lists, substituting for those in common use the abbreviations of their class and family or order. Thus *Inscoccidus psidii* indicates an animal (us), insect (ins.), coccidæ (coccidus) belonging to the species *psidii*. The family (Cocciceroplastus psidii) is more difficult of interpretation, since at least 1,000 families of animals have been accepted.

5. In case there be two similar species in the same family of animals their genus shall be cited.

The reform proposed does not alter or change anything, but facilitates research, as well as the applications, popularization and teaching of science. There are no future inconveniences in the acceptance of this reform. No Inter-

national Congress is required, since the abbreviations present no difficulties.

A. L. HERRERA.

MUSEO NACIONAL, MEXICO.

TIDES AND CURRENTS IN CANADIAN WATERS.

TO THE EDITOR OF SCIENCE: Permit me to invite your attention to the latest report of the engineer in charge of the survey of the tides and currents of the coast waters of Canada, Mr. W. Bell Dawson, M. A., M. E., etc., a copy of which has been addressed to you. This survey, commenced by the government of Canada in 1894, is of great importance, not merely in the interest of hydrographical science, but of the large and increasing trade which finds its way along the Gulf and River St. Lawrence, the greatest waterway from the north Atlantic into the northern part of the American continent, and which, like all similar tide-ways, is affected by the complex action of the tides and consequent currents.

It is much to be regretted that the economy or parsimony of the government has caused a suspension for the present of the special survey of the currents, and has restricted the work to tidal observations, which, though of great value to the shipping interests, can only be considered as preliminary in regard to the investigation of the currents themselves, which lead to so many losses of property and life, and tend to high rates of insurance, injurious to the ship owners and merchants of Canada, and, through them, to those of an empire as a whole.

The present report, in addition to what can be done with the insufficient grant allowed in the matter of tide-gauges and tide-tables, has reference to the behavior of the gigantic tides of the Bay of Fundy, when confined by the converging coasts at the head of the bay, and their relation to the smaller tides on the opposite side of the isthmus connecting Nova Scotia and New Brunswick, at Bay Verte, on the Gulf of St. Lawrence. These and the phenomena of the 'bore' at the head of the Bay of Fundy are here for the first time described, illustrated by maps and sections, and tabulated, and will be found of the greatest interest by all who desire information as to the exceptional tides of this region.

NATURAL HISTORY OF THE TRES MARIA ISLANDS, MEXICO.

THE latest publication from the Division of Biological Survey of the U. S. Department of Agriculture, being 'North American Fauna, No. 14,' bears the title at the head of this notice. It contains the result of an exploration made in the spring of 1897 by Mr. E. W. Nelson and Mr. E. A. Goldman during the month of May of that year, and adds largely to our previous knowledge of the fauna and flora of these islands. The more appropriate title to the paper would be 'Contributions to the Natural History,' etc., for no *insecta* are mentioned and *only six* species of mollusks; of these *four* had not been previously known to occur. The author, after mentioning the names of Col. A. J. Grayson and Alphonse Forrer, says 'no other naturalist is known to have visited the islands until the spring of 1897,' the season of his visit. He should have known that the islands were visited in the spring of 1876 by Mr. W. J. Fisher, previously naturalist of the Tuscarora Telegraph Sounding Expedition, directed by Commander George E. Belknap in 1873. Mr. Fisher made a large collection of molluscan forms as published in the Proc. U. S. Nat. Museum, pp. 139–204 of Volume XVII., 1894, wherein 89 species are listed.

It is not unlikely that both Grayson and Forrer collected many insect species which have been published somewhere. Only the mollusks collected by Fisher have come under my notice.

ROBERT E. C. STEARNS.

LOS ANGELES, CAL., June 26, 1899.

NOTES ON INORGANIC CHEMISTRY.

No little work has been done on the compounds of sulfur and iodin, but with no very satisfactory results. The latest contribution is by L. Prunier in the *Journal de la pharmacie et de la chimie*, and it can hardly be said that the subject is left in a much clearer condition. Prunier distinguishes between what he calls 'iodized sulfur' and 'sulfur iodid.' The former is made by adding the desired quantity of iodin to sulfur at 115° to 120°, stirring, cooling and preserving in a stoppered bottle. The iodin

volatilizes very readily and is rapidly extracted from the finely pulverized substance by sodium thiosulfate solution. The sulfur left after the extraction of the iodin is readily soluble in carbon bisulfid. It would seem that in the 'iodized sulfur' the iodin is merely dissolved in the sulfur. The 'sulfur iodid' is prepared by adding pulverized iodin to sulfur heated to 200°. While cooling, the mass is poured into cold water and then powdered. The iodin cannot be dissolved out by thiosulfate solution and seems to be in chemical combination. The color of the sulfur iodid is yellowish red; that of the iodized sulfur brownish black. Both substances, especially the latter, are energetic therapeutic agents.

The question of the form in which iodin occurs in the sea water has received a new answer from Armand Gautier in the *Comptes Rendus*. It is questionable how much experimental evidence can be deduced to show the presence of sodium iodid or calcium iodate, though both of them have been proposed. Gautier claims that all the iodin in sea water is in the form of organic compounds. About one-fifth is combined in algæ and spores, and the remainder in the form of soluble organic compounds; the latter are in part derived from the decomposed algæ, and are in turn assimilated by other algæ. It would be an interesting thing to have this question settled once for all, but the problem is one of great difficulty.

There is also presented in the *Comptes Rendus* a study by M. De Forcrand of the chemical function of water compared with that of hydrogen sulfid. From the heats of formation of the oxids of sodium the author concludes that the two hydrogen atoms in a molecule of water are distinctly different in function, and hence that water possesses an asymmetrical formula which he would represent by H—OH. In hydrogen sulfid, on the other hand, he considers the hydrogen atoms of equal value, and it consequently possesses a symmetrical formula H—S—H.

According to the *Pharmaceutische Central-Halle* Varino has succeeded in preparing a colloidal form of bismuth. The very diluted solution of bismuth tartrate in potassium tartrate is treated with a solution of stannous chlorid in caustic potash. A clear brown fluid results, from which very little bismuth precipitates, and which acts toward the electrical current in a similar manner to colloidal gold.

According to the *Chemical News*, one of the the most interesting exhibits at the recent Royal Society Conversazione was the series of experiments by Mr. W. A. Shenstone and Mr. W. T. Evans, showing the manufacture of tubes of rock crystal in the oxyhydrogen blowpipe flame. Tubes of one centimeter in diameter, composed of rock crystal, can now be made of considerable length at the rate of about three centimeters an hour. This is of great practical as well as theoretic interest.

J. L. H.

RECENT PROGRESS IN THE EXAMINATION OF FOODS AND DRUGS.

PLANT PRINCIPLES.

As the result of some investigations on the carbohydrates in bulbs, tubers, etc., L. du Sablon* gives the following information: The reserve materials in the tubers of potato, rhizomes of *Arum* and *Iris* and the corms of *Colchicium* and *Ranunculus* consist almost entirely of starch, with small quantities of dextrin and sugar. In the tubers of *Ophrys* and the bulbs of *Lolium*, *Tulipa* and *Hyacinthus* the reserve is made up of starch and dextrin. In the corm of *Ficaria* starch, dextrin and non-reducing sugars are present. In the tubers of *Dahlia* inulin and levulin are found; whereas in the tubers of the artichokes, besides the inulin and levulin, non-reducing sugars are present. Chiefly reducing and non-reducing sugars are to be found in the bulbs of *Allium* and *Asphodelus*. The experiments of du Sablon seem to show that the starch is transformed into dextrin, then into non-reducing sugars and finally into reducing sugars.

Inulin has been found by H. Fischer† to occur in most of the tribes and a large number of genera of the N. O. Compositæ. It is also found in the Campanulaceæ, Lobeliaceæ, Goodeniaceæ, Stylidaceæ, etc. He assigns to it the formula 333 $C_6H_{10}O_5$ or $C_{1998}H_{3330}O_{1665}$.

* Bonniers Rev. Gén. de Bot., 1898; Ibid., p. 295.

† Cohn's Beitr. Biol. Pflanz., 1899, p. 53.

The essential oil of orange flowers (*Citrus aurantium amara* L. and *C. bigaradia* Dick) has been examined by E. and H. Erdmann,* and they find it to contain (0.129 gms. per kilo of oil) anthranilic methyl ester. It is supposed that the fluorescence of the oil is due to this ester.

Jasmal, or methylene acetal of phenyl-glycol, is the name given by A. Verley † to a principle which he has made synthetically and which it is claimed possesses the characteristic odor and other properties of the principal odorous principle of jasmine. The West Indian sandalwood oil ‡ is recognized by E. M. Holmes as coming from a new genus and species of the N. O. Rutaceæ, and named by him *Schimmelia oleifera*.

The oleoresin of *Dacryodes hexandra* Griseb. (N. O. Burseraceæ) has been found by A. More ⁂ to consist of an essential oil, a resin and a crystalline substance. The oil contains lævorotatory pinene and lævorotatory sylvestrine. The crystalline principle is insoluble in water and is only sparingly soluble in strong alcohol, and appears to be identical with Personne's ilicic alcohol.

Gum M'beppe, or Kongosita, has been identified by E. Heckel ‖ as the product of *Sterculia tomentosa* Guill et Perrot. It is distinguished from tragacanth in that it does not give any coloration with iodine and yields 7.24 per cent. of ash.

According to F. C. Newcombe ¶ the enzyme of *Asperigillus oryzæ* acts with greater intensity upon reserve cellulose than upon starch, while the enzymes of *Lupinus albus* and *Phœnix dactylifera* act so strongly on reserve cellulose and so feebly upon starch that they may be regarded as cystase rather than as diastase. S. H Vines ** has continued his studies on the enzyme of *Nepenthes* and says that, like all the vegetable proteolytic enzymes, it is probably tryptic in character, being more stable in its nature and more rapid and energetic in its action than that contained in germinating seeds, which it closely resembles.

* Ber. d. D. Chem. Ges., 1899, p. 1213.
† Bull. Soc. Chim., 1899, p. 226.
‡ Pharm. Jour. (London), 1899, p. 53.
⁂ Chem. News, 1899, p. 284.
‖ Ext. Rev. d. Cult. Col.; through Pharm. Jour., 1899, p. 139.
¶ Annals of Botany, 1899, p. 49.
** Ibid., p. 545.

FOODS AND SPICES.

AT a recent meeting of the Incorporated Society of Medical Officers of Health,* England, the following resolutions were adopted: (1) 'That the Incorporated Society of Medical Officers of Health strongly disapproves of the practice of adding preservative chemicals to milk and other foods;' (2) 'that if preservative chemicals be added to any food a full disclosure as to the nature and amount thereof should be made.'

It is not unusual to find some of the exhausted umbelliferous fruits in adulterated pepper, but T. F. Hanausek † records for the first time the employment of exhausted coriander to adulterate a sample of pepper.

A. Juckenack and R. Sendtner ‡ have examined the fennel from Germany, Italy, Macedonia and Galicia. They find in all cases upon placing the exhausted fennel in water that the fruits become dark colored and sink, whereas the genuine fruits retain their color and float. Upon making a microscopical examination a marked difference is also observable. The author also notes that from 70 to 80 per cent. of the fruits of fennel should be capable of germination. He has not found any specimens in which chrome yellow was used to improve the appearance of the fennel, although he has met some samples in which ochre had been employed.

The ash of the fruits and seeds of *Ellettaria cardamomum* Maton (N.O. Zingiberaceæ) always contain manganese. According to W. W. Will ⁂ the ash is found in the following percentage in the different parts: (1) whole seeds, 3.26; (2) crushed seeds, 3.52; (3) pericarp of fruit, 5.96 to 6.17; (4) entire fruits and seeds, 3.84 to 4.22.

A sample of coffee which had caused symptoms of poisoning in the members of a family drinking the infusion was examined by S.

* The Analyst.
† The Analyst.
‡ Zeitschr. f. Nahr. u. Genuss., 1899, No. 4.
⁂ Chem. News, 1899, p. 167.

Bein.* He failed to detect the usual metallic or alkaloidal poisons, but found a ptomaine, which arose probably either through the spoliation of the coffee by means of sea water or by overroasting the product. Massee,† describes a blight (*Pestallozzia guepini* Dermaz) which occurs on the tea plantations of Assam and is doing considerable damage.

The well-known property, which formaldehyde possesses, of forming insoluble compounds with proteid substances, and applied by Beckmann to the estimation of gelatin and albumin in peptones, has been recently applied by Trillat‡ to the detection and estimation of gelatin in general and especially when mixed with gums.

In the examination of various cereals A. van Bastelaer§ finds that upon heating 1 part of the cereal with 5 parts of water at a temperature of 11 to 12° C. for 1 hour that certain characteristics are brought out; rye giving a rather viscous solution; linseed and buckwheat yielding a thick mucilage; whereas wheat, rice, spelt, barley and oatmeal give solutions of rather even viscosity. He further finds that the leguminous cereals, upon shaking the solutions, develop a large amount of froth, whereas the solution of corn does not froth. All of the cereals, with the exception of rice, yield a precipitate with picric acid, the largest amount of precipitate having been produced with the leguminous cereals. Alcohol, likewise, produces a precipitate with solutious of rice, barley, buckwheat and the leguminous cereals the precipitate of the leguminous cereals and flaxseed being soluble in ammonia.

Henry Kraemer.

Philadelphia College of Pharmacy.

POSITION OF WOMEN IN BABYLONIA.

A recent treatise by Victor Marx defines the position of women in Babylonia during the period 604–485 B. C., as illustrated by the contract literature of the times; his treatise forms half of Heft 1, Band IV., of the Beiträge zur Assyriologie und semitischen Sprachwissenschaft, Leipzig, 1899; and is reviewed at some length by J. Dyneley Prince in the *American Journal of Philology*, Vol. XX., pp. 104–106. The contracts indicate that Babylonian maidens held property in their own right, and that there were definite marriage stipulations relating to dowry, incidentally indicating the dependence of the son on his father's wishes in the choice of a wife. The dowry contracts were definite, stating the amount and nature of the property to be given, providing for payment by instalments and arranging for payment by a brother in case of the father's decease, the dowry being regarded as a legally collectable debt, payable in kind if money were lacking. The legal recipient of the dowry was the son-in-law, yet the daughter (wife) retained such proprietary interest therein that if invested in realty by the husband it was in the wife's name. Married women were competent to conduct transactions relating to money, to realty, and to slaves, their contracts being sometimes witnessed by the husband; while various business transactions were performed in common by husband and wife, the former being alone responsible as guarantor, the mere presence of the wife giving legality to the husband's transactions, at least in certain cases. There are indications that husband and wife enjoyed approximately equal rights with respect to property, the control of children, etc.; there is little reference to the husband's duty to support the wife, though it appears that in case of divorce the husband paid alimony according to his means. Frequent reference to slaves appears in the contracts, but the author postpones discussion of the subjects of slavery and of the condition of female slaves. The information brought to light through the study of these ancient contracts bears on the development of institutions. Apparently the regulations governing the contracts studied pertained chiefly to urban life; certainly the regulations seem hardly in accord with the customs prevailing among contemporary nomadic tribes and still maintained among their descendants of similar habit.

W J M.

* Zeitschr. f. angew. Chem., 1898, 658; Analyst, 1899, p. 36.

† Pharm. Zeit., 1899, p. 749.

‡ Ann. Chim. Anal. App., 1898, p. 401; Analyst, 1899, p. 35.

§ Jour. Pharm. Chim., 1898, VIII., 43; Pharm. Centralb., 1899, p. 303.

AMERICAN MATHEMATICAL SOCIETY.

FOR several years the need of greater facilities for the publication of mathematical investigations has been strongly felt by the members of the American Mathematical Society. This Society has maintained during the past eight years an historical and critical review, known as the *Bulletin of the American Mathematical Society*, and throughout the whole of this period there has been a constantly growing demand for the publication in the pages of this journal of articles not properly falling within its scope. The Society, feeling that the time has come when further provision must be made for the publication of such articles, recently invited the cooperation of several American colleges and universities in a plan whereby such articles may be afforded suitable means of publication.

The necessary cooperation has now been secured, and the publication of the *Transactions of the American Mathematical Society* has been definitely undertaken to begin January 1, 1900. The cooperating institutions are Harvard University, Yale University, Princeton University, Columbia University, Haverford College, Northwestern University, Cornell University, The University of California, Bryn Mawr College and The University of Chicago. It is the desire of the Society that the *Transactions* may cooperate with existing journals in developing a wider and more active interest in mathematical research. Among American journals the *Annals of Mathematics* will encourage papers of pedagogic nature and brief researches of general interest; the *Bulletin of the American Mathematical Society* will maintain its character as an historical and critical review, and the *American Journal of Mathematics* and the *Transactions of the American Mathematical Society* will together, it is hoped, afford adequate facilities for the publication of the rapidly increasing volume of the more technical mathematical papers.

The *Transactions* will be devoted primarily to research in pure and applied mathematics. The editors will welcome all papers containing investigations of sufficient mathematical interest and value. Such papers, in many cases, will be, necessarily, of considerable length; but the editors will be very glad to receive, also, short contributions which are of such a character as to fall within the scope of the *Transactions*. Papers from mathematicians not belonging to the Society will be welcomed; such papers, if accepted for publication, will be presented to the Society by the editors.

The *Transactions of the American Mathematical Society* will be published quarterly. The first number will appear January 1, 1900. The page of the *Transactions* will be the same size as that of the Berlin *Sitzungsberichte*. The subscription price for the annual volume of at least four hundred pages is five dollars, twenty shillings, twenty Marks, or twenty-five francs. A reduction in price will be made, however, to the members of the American Mathematical Society. Subscriptions and payments should be sent to the office of the American Mathematical Society, 501 West 116th Street, New York. Cheques and postal money orders should be made payable to the American Mathematical Society.

Manuscripts intended for publication in the *Transactions* should be addressed either to Professor E. H. Moore, University of Chicago, Chicago, Ill., or to Professor F. W. Brown, Haverford College, Haverford, Pa., or to Professor T. S. Fiske, Columbia University, New York, N. Y.

SCIENTIFIC NOTES AND NEWS.

LORD KELVIN, who for fifty-three years has occupied the chair of natural philosophy at Glasgow, presented to the University Court on July 13th a petition for leave to retire. The Court granted the leave asked, and accepted Lord Kelvin's resignation with deep regret. A remit was made to the Principal to prepare a minute to be signed by all the members of the Court, expressing their sense of the great loss that the University is now to sustain.

PROFESSOR F. ZEEMAN, of Amsterdam, has been awarded the Baumgartner Prize of the Vienna Academy of Sciences, and Dr. K. Natterer, docent in chemistry in the University of Vienna, the Lieben Prize of the Academy.

THE Academy of Sciences of Berlin has given Professor Engler 4,000 Marks for work in botany.

THE third Conference of Astronomers and

Astrophysicists will be held at the Yerkes Observatory on Wednesday, September 6th, and the two following days.

A MONUMENT to Gauss and Weber was unveiled at Göttingen on June 17th, the chief address being made by Professor Voigt, Weber's successor. As part of the ceremonies the honorary doctorate was conferred on Professor Moore, of Chicago; Professor Darwin, of Cambridge; Professor Hadamard, of Paris; Professor Lorenz, of Leiden; Professor Righi, of Bologno, and Professor von Sterne, of Vienna.

THE Volta Exhibition at Como has been completely destroyed by fire, attributed to the fusing of electric wires. Many precious relics of the great electrician were lost in the flames, notwithstanding the precaution taken to preserve the objects by placing them in a receptacle of solid masonry. The committee has decided that the *fêtes* in honor of Volta shall be continued. The International Congress of Electricians will also be held, as previously arranged.

IT is reported that Mr. R. T. Glazebrook, Principal of University College, Liverpool, has been appointed Director of the recently established National Physical Laboratory of Great Britain.

SIR WILLIAM MACCORMAC has been for the fourth time elected President of the Royal College of Surgeons, London.

DR. J. WIESNER, professor of plant physiology, of the University of Vienna, has been elected a member of the Berlin Academy of Sciences.

DR. F. WÄHNER, privatdocent in geology in Vienna, has been elected a member of the Leopoldinisch-Carolinisch Academy at Halle.

A DINNER was given to Sir John Burdon-Saunderson, Bart, and Professor Michael Foster, K.C.B., by British physiologists on July 25th, to congratulate them on the honors recently conferred on them by the Queen.

IT is reported that Professor Sanarelli is about to visit the United States to study the effects of his serum in the treatment of yellow fever.

THE British Cancer Society has commissioned Mr. Arthur C. Buffey, M.B., B.Ch., to go to the United States to report generally on matters affecting the objects of the Society, and especially as to the operations of the State Laboratory for the study of cancer at Buffalo, N. Y.

WE learn from *Nature* that Mr. H. H. Howell, who joined the British Geological Survey under De la Beche in 1850, has retired from the service. Mr. Howell, after surveying some portions of Wales and the south of Scotland, and large areas in the midland counties of England, became District Surveyor of the north-eastern counties of England in 1872; he was appointed Director for Scotland in 1882 (when Sir Archibald Geikie became Director-General), and he was further promoted to be Director for Great Britain in 1888. Mr. Ernest E. L. Dixon, who has for the past two years acted as assistant to Professor Judd at the Royal College of Science, has been appointed Assistant Geologist on the Geological Survey of England.

A MARBLE bust of the late William Rutherford, professor of physiology at Edinburgh, given by his recent students, was unveiled on July 8th. After the bust, which is by Mr. John Hutchinson, had been unveiled, a speech was made by Sir William Turner.

WE regret to learn of the death of Mrs. Elizabeth Thompson, of Stamford, Conn., who made many gifts for benevolent and scientific purposes. She contributed towards the telescope for Vassar College, was one of three 'patrons' of the American Association for the Advancement of Science, and endowed the Elizabeth Thompson Science Fund, the income of which is now being so advantageously used for the promotion of scientific research.

W. P. JOHNSON, LL.D., President of Tulane University, New Orleans, and a Regent of the Smithsonian Institution, died on July 16th.

MR. CHARLES M. FAUNCE, formerly instructor in descriptive geometry at the Massachusetts Institute of Technology, has died at the age of 32 years.

PROFESSOR H. R. GEIGER, from 1846 to 1882, professor of science in Wittenberg College, and

later connected with the U. S. Geological Survey, died at Springfield, Ohio, on July 18th.

DR. WILHELM WHITMANN, professor of mechanical engineering in the School of Technology at Munich, has committed suicide.

MR. J. W. HENDRIE, a Life Member of the California Academy of Sciences, has presented to the Academy, without condition or qualification, securities to the value of $10,000. By action of the Council and Trustees of the Academy, the gift has been set aside to be known as the Hendrie Publication Fund, the interest of which shall be applied towards the publication of the papers of the Academy. Each paper published from the income of this fund will bear the inscription, 'Printed from the Hendrie Publication Fund.'

BY the will of the late Frau M. Jankowska, of Warsaw, the Academy of Sciences at Cracow has received 20,000 roubles.

PRINCE JOHANN LICHTENSTEIN has given the Vienna Academy of Sciences 25,000 florins for explorations in Asia Minor. The Academy has also received 18,000 florins for the increase of the Lieben foundation.

ANDREW CARNEGIE has offered from Scotland to give $50,000 towards a public library building at Steubenville, Pa., if the citizens will furnish a site and maintain it. Mr. Carnegie in his letter refers to his early days when a telegraph operator in Steubenville. His offer will be accepted.

THE Union Pacific Scientific Expedition left Laramie on July 21st. The company was made up of twenty teams and nearly 100 men, including representatives from many leading colleges and universities. The expedition will remain in the field for forty days.

A PARTY of between twelve and fifteen advanced students of geology from the University of Chicago are to make a trip to Arizona and New Mexico during the later part of the summer for field study. The party will leave Chicago on the 10th of August and be gone about five weeks. The party is under the direction of Professor Rollin D. Salisbury, and will in the course of its work make a trip to the Grand Cañon of the Colorado north of Flagstaff. A party of fifteen from the University is now in the field in south-central Wisconsin, and another party is to go into the same region in August. A party of students of botany, under the direction of Dr. Henry C. Cowles, will take a field course during the later part of the summer. These field courses, both in geology and botany, are reckoned as a regular part of the University work.

DR. F. W. SARDESON, of the University of Minnesota, accompanied by Rev. F. S. Moore and W. B. Stewart, has gone on a collecting expedition into the Big Horn River Valley of northwestern Wyoming. The rocks are Tertiary and locally are said to be very fossiliferous. The party will be gone until September. The expenses of the season will be met by several business men of Minneapolis and St. Paul.

AMERICAN men of science visiting Paris may be interested to learn that there are meetings of naturalists held monthly at the Paris Museum of Natural History. They are held at 4 o'clock in the afternoon on the last Tuesday of the month.

A NEUROLOGICAL Society was formed in Paris on June 8th, with Professor Joffroy as President. The Society will issue the *Revue Neurologique*, which will appear on the 15th of each month.

A CONGRESS of Aerial Navigation with M. Janssen as President is being arranged to meet at Paris during the Exposition. There will be five sections devoted respectively to balloons, flying machines, scientific instruments, applications to science and legal questions.

THE British Colonial Office announces that the bubonic plague has spread from Hong Kong and Mauritius to Reunion. There were thirty-six cases at Mauritius during the week ending July 20th, of which twenty-nine resulted fatally.

WE learn from the London *Times* that the annual meeting of the Society of Chemical Industry was opened on July 12th, at Newcastle-on-Tyne. Mr. George Beilby, of Edinburgh, President of the Society, was in the chair. At the Durham College of Science, where the delegates were welcomed to the city by the mayor, Professor C. F. Chandler, of Columbia Univer-

sity, was elected President for the ensuing year. The Council's report, which was adopted, stated that the number of members on the register was 3,312 compared with 3,185 at the last annual meeting. The President, in the course of his address, dealt with the rapid exhaustion of British coalfields and the serious increase of smoke pollution. The remedies were broadly divided into two classes: first, improved appliances for the combustion of raw coal and distribution of the air supply in furnaces; and, secondly, the transformation of the raw coal into smokeless fuel by preliminary treatment. The effects of the natural development of certain industries on the markets for by-products were next considered. It was pointed out that if any considerable part of the 137 million tons of coal which is at present burned in the raw condition were to be converted into gas, coke and ammonia an altogether new condition of things would arise which would need to be foreseen and provided for. A careful study of the whole subject has led to the conclusion that the natural outlet for the coke and pitch would be found in the manufacture of fuel briquettes, and the President advocated the turning of the very best technical skill to the perfecting of the manufacture. He believed that with skill and enterprise it would be possible to make briquettes exactly suited for every purpose from boiler firing to domestic cooking. As a means of bringing all of the different interests which are concerned in this matter into line, it was suggested that the Society might arrange for the holding of a conference on the subject of fuel and smoke, at which the leading technical societies, as well as the actual industries concerned, should be fully represented.

UNIVERSITY AND EDUCATIONAL NEWS.

O. Hölterhoff, a banker of Honnet, has bequeathed his property valued at about 1,000,000 Marks to the University at Bonn.

Mrs. John L. Newberry, of Detroit, Mich., has given to Western Reserve University, Cleveland, O., $2,500 to found the Handy philosophical prizes, in honor of her father, Mr. J. P. Handy, of Cleveland.

Professor Benjamin Ide Wheeler, of Cornell University, has accepted the presidency of the University of California.

Mr. E. A. Minchin, Fellow of Merton College, Oxford University, has been elected to the Jodrell professorship of zoology in University College, London, in succession to Professor W. F. R. Weldon, who, it will be remembered, was recently called to Oxford.

Dr. A. Fick, professor of physiology at Würzburg, has retired. The chair was offered to Professor W. Biedermann, but he has refused to leave Jena.

Dr. B. Peter has been made associate professor of astronomy at Leipzig and sub-director of the observatory.

Dr. A. Philippson, geography, and Dr. K. Mönnichmeyer, astronomy, docents at Bonn, have been made titular professors.

An associate professorship for physical anthropology has been established at Zurich and filled by the election of Dr. R. Martin.

At the University of Paris courses have been authorized by M. Guignard on the application of chemistry to brewing and distilling; by M. Loisel on comparative embryology, and by M. Martel on speleology or subterranean geography.

There are during the present summer semester 4,997 students matriculated at the University of Berlin, which is an increase of 349 as compared with last year. There are 655 foreigners.

According to the *Hochschul-Nachrichten* 22% of the professors in the German universities are engaged in lecturing or laboratory supervision 2 to 6 hours a week and 51% from 7 to 12 hours. Of the associate professors 60% are engaged from 2 to 6 hours per week and of the privatdocents 82%. Only 4% of all privatdocents are engaged in lecturing or laboratory supervision more than 12 hours a week. The leisure, accompanied it must be admitted by poverty, of the German associate professors and docents explains in large measure the amount of research work accomplished in German universities.

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DANIEL GARRISON BRINTON, Professor of American Archæology and Linguistics in the University of Pennsylvania and Professor of Ethnology and Archæology in the Philadelphia Academy of Sciences, one of the editors of this JOURNAL, died on July the thirty-first, in his sixty-third year.

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